ITL.1118US
(P18790)

APPLICATION

FOR

UNITED STATES LETTERS PATENT

TITLE: THERMOELECTRICALLY COOLING ELECTRONIC DEVICES

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Express Mail No. EL 990 136 057 US

Date: March 19, 2004

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THERMOELECTRICALLY COOLING ELECTRONIC DEVICES

Background

This invention relates generally to techniques for cooling integrated circuits.

Integrated circuits may develop heat in the course of operation. This heat may result in device failure. It may also adversely affect the performance of the overall system, including the electronic device. Therefore, it is desirable to cool the electronic device and systems using the electronic device.

To this end, a variety of cooling techniques have been used for cooling electronic devices. A thermoelectric cooler generates cool temperatures proximate to an electric component. The thermoelectric cooler may operate in conjunction with a heat sink. In such cases, there is a need for techniques for joining the heat sink, the thermoelectric cooler, and the component to be cooled.

Because the heat sink may have relatively little rigidity, simply bolting the parts together may result in bending moments at the edges, which may result in bowing of the heat sink. Such bowing of the heat sink may result in insufficient thermal interface between the heat sink and the thermoelectric cooler. That insufficient thermal interface results in less effective cooling. Using a thicker heat sink base is one solution. However, the

resistance to thermal dissipation is a function of the thickness of the heat sink base.

Thus, there is a need for better ways to form thermoelectric cooling devices for electronic circuits.

Brief Description of the Drawings

Figure 1 is an exploded view of one embodiment of the present invention;

Figure 2 is an enlarged, cross-sectional view of the vapor chamber shown in Figure 1 in accordance with one embodiment of the present invention;

Figure 3 is a perspective view of the retention band shown in Figure 1 in accordance with one embodiment of the present invention;

Figure 4 is a perspective view of the assembled cooling device in accordance with one embodiment of the present invention, viewed at an angle from above;

Figure 5 is a perspective view corresponding to Figure 4, viewed from below; and

Figure 6 is a side view of a system using the cooling structure shown in Figures 1 through 5 in accordance with one embodiment of the present invention.

Detailed Description

Referring to Figure 1, a finned heat sink 12 may include a large number of fins 13 coupled by a flexible base 15. The fins 13 may be formed as parallel plates

secured to the base 15 in one embodiment of the present invention. Below the heat sink 12 is a thermoelectric cooler 14. Underneath the thermoelectric cooler is a vapor chamber 16 for the thermoelectric cooler 14. A vapor chamber support frame 18 underlies the vapor chamber 16.

Referring to Figure 2, the vapor chamber 16 may include a top wall 22, a bottom wall 28, and a sidewall 24. Standoffs 26 may allow room for a liquid/vapor phase 30 between the walls 24 and 28.

Referring to Figure 3, in accordance with one embodiment of the present invention, a U-shaped clamp or retention band 11 may include a bowed or pre-bent, leaf spring connecting portion 32 and downwardly extending transverse arms 34. The free end of each arm 34 may include a bolt retainer 36 and an upstanding bolt 38 in one embodiment of the present invention. The band 11 may be resilient in one embodiment.

The components of Figure 1 may be secured together using the retention band 11. In particular, as shown in Figures 4 and 5, the band 11 may traverse the heat sink 12. Damage to the heat sink 12 may be avoided by providing the fin array plate 20, which further stabilizes the heat sink 12. The entire structure is clamped together by the juxtaposition of the bolts 38 against the bottom of the vapor chamber support frame 18. In some embodiments, the amount of force applied may be adjusted by adjusting the

amount by which the bolts extend through the retention units 36. In addition, the force applied is controlled by the pre-bending of the connecting portion 32.

Referring to Figure 6, the cooling structure 10 may be mounted over a package 44 having a shape adapted to receive the bolts 38 and bolt retainers 36. A substrate 46, socket 48, and a printed circuit board 50 may be provided to connect the cooling device 10 to an appropriate electronic system. A fan 42 may force air through the heat sink 12, in one embodiment of the present invention, in a direction parallel to the length of the heat sink fins 13. Heat given off by the thermoelectric cooler 14 is removed to the atmosphere by the flow of air over the heat sink 12.

In some embodiments, the components may be made up by providing a thermal interface material, such as grease, between the various layers. A minimum pressure between the thermoelectric cooler surfaces, the heat sink, and the vapor chamber may provide the desired thermal resistance at those interfaces. In some cases, it is advantageous to provide the air flow from the side of the heat sink instead of the top. Multiple retention bands may be utilized to ensure that the load is spread evenly across the entire fin array in some embodiments. If it is desired to maintain the open area at the top of the fin array, several smaller bands, spaced from one another, may be employed. In other cases, a single, solid, retention band may be utilized.

In some embodiments, a thermoelectric cooler stackup may be utilized without providing unnecessary bending. These bending problems may break the good thermal interface between the components. It may also be desirable to provide the stackup without unduly thickening the base of the heat sink. Because of the band 11, the compressive load may be distributed over the entire fin array in some embodiments. In addition, using threaded connectors may interfere with the operation of the thermoelectric cooler and may result in loss of heat transfer area.

While the present invention has been described with respect to a limited number of embodiments, those skilled in the art will appreciate numerous modifications and variations therefrom. It is intended that the appended claims cover all such modifications and variations as fall within the true spirit and scope of this present invention.

What is claimed is: